RaveGrid: Raster to Vector Graphics for Image Data

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We present RaveGrid, a software that efficiently converts a raster image to a scalable vector image comprising polygons whose boundaries conform to the edges in the image. The resulting vector image has good visual quality and fidelity and can be displayed at various sizes and on various display screen resolutions. The software can render vector images in scalable vector graphics (SVG) or encapsulated postscript (EPS) formats. The ubiquity of images, on the Web and in communications, as well as the wide range of devices, from big-screen televisions to cellular phones that support image display, calls for a scalable and more manipulable representation of imagery. Moreover, with the growing need for automating image-based search, object recognition, and image understanding, it is desirable to represent image content at a semantically higher level by means of tokens that support computer vision tasks.

Algorithm. Our software is based on *VISTA*, a broad algorithmic framework [1] for performing image segmentation that exploits both region and edge cues inherent in images. Perceptual organization of regions and edges into polygonal segments is modeled using the proximity-based regional relationships between edges established by Delaunay triangulations. More precisely, a digital image is processed to extract edge pixel chains and a constrained Delaunay triangulation of the edge contour set is performed to yield triangles that tile the image without crossing edge contours. Each triangle is attributed a color by sampling pixels within it. A combination of rules, each of which models an elementary perceptual grouping criterion such as proximity or continuity, determines which adjacent triangles should be merged. A grouping graph is formed with vertices that represent triangles and edges between vertices, and that correspond to adjacent triangles to be merged according to the combination of grouping rules. Connected components of the grouping graph then yield collections of triangles that form polygons that segment and vectorize the image.

Implementation. Our software takes as input a digital raster image comprising pixels and an optional quality parameter—the level of detail (LOD) that controls the hysteresis thresholds in a Canny edge detector. The steps of the algorithm sketched above are efficiently implemented in C, and a graphical user interface (GUI) displays both the raster input image and the vector output image. The details of the vectorization can be compared by synchronous zoom and pan functionalities. The result may be stored as a gzip compressed SVG or EPS document.

Performance. RaveGrid currently vectorizes an average of two VGA resolution (640x480) frames per second (or about 1.75 s/MP) on a 2.5 GHz Pentium 4 CPU with 1 GB of RAM, scaling linearly to over 30 mexapixels (Fig. 1). At the lowest quality setting, it serves as an image segmenter, while at higher quality settings it renders high visual quality vector images. Figure 2 shows a sample image of red and green chiles vectorized at different LODs: high, medium, and low. At the high LOD the vectorized image is indistinguishable from the original. As we lower the LOD, even though fine details and highlights disappear, the perceptual content of the image is preserved making this approach amenable to multi-scale object analysis.

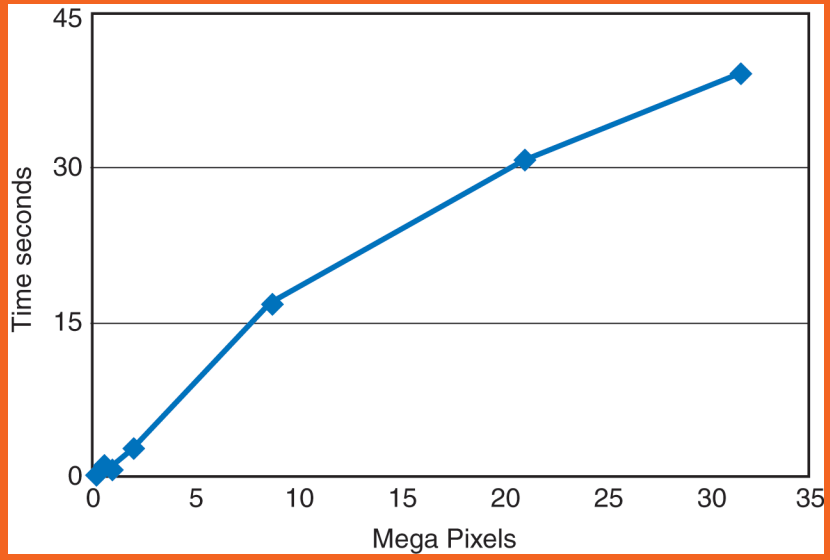

Fig. 1. Scaling of RaveGrid as a function of image size.

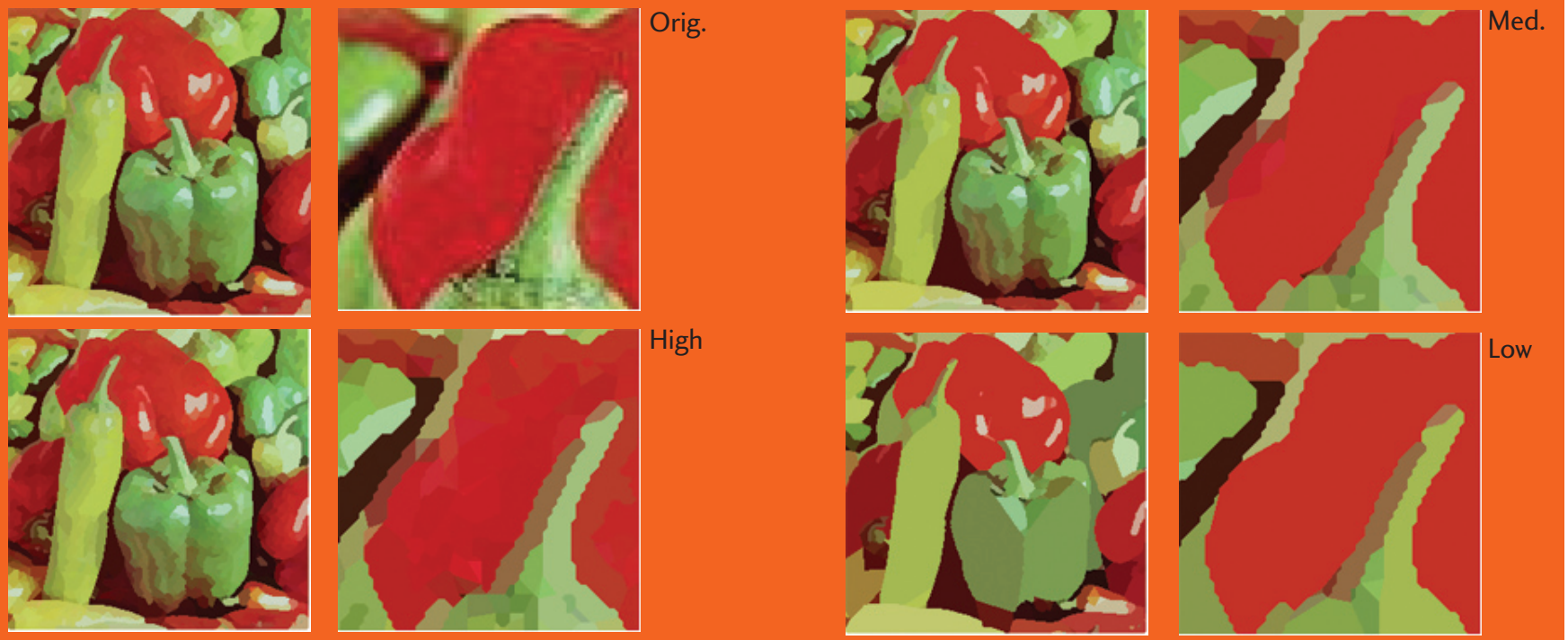

Fig. 2. An image of red and green chiles vectorized at different levels of detail (LOD): high, medium, and low. Finer details in the image disappear with decreasing LOD, but the perceptual content of the image is preserved so that even at Low LOD the chiles are easily identifiable.

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[1] L. Prasad and A. Skourikhine, *Pattern Recognition,* **39,** 501-514 (2006).

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